

## **REMARKS**

The Office Action of October 23, 2006, has been carefully considered. Claims 1-24 are pending in the application. Each of the objections and rejections in the Office Action are addressed in the following remarks. In view of the following remarks, Applicant respectfully requests reconsideration and allowance of the subject application.

Applicant would also like to thank examiner in a brief interview on January 26, in which the amendment to the claims were briefly discussed and it was agreed that applicant would file an RCE with the claim amendments.

### **Claim Rejections Under 35 USC §102(b)**

Claims 1-24 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent 6,308,185 to Grarup. (hereinafter referred to as the Grarup reference).

In overview, in order for prior art to anticipate a claim under 35 U.S.C. §102 every element of the claimed invention *must be identically disclosed* either expressly or under principles of inherency in a single reference. Further, the exclusion of a claimed element from a prior art reference, no matter how insubstantial, is enough to negate anticipation by that reference. The test of whether anticipation exists in a particular case is a question of fact, and is applied element-by-element to a single prior art reference. Only if the prior art literally reads on every element of the rejected claim will the claimed invention be anticipated under this test.

With this in mind, the Applicant analyzes the §102 rejection of the claims in the present application.

**Claim 1** has been amended to clarify the elements that are not disclosed by the Grarup reference. For convenience, amended Claim 1 is reproduced below with portions in bold to better emphasize some of the elements that are not disclosed in the Grarup reference.

1. A computer-readable medium having computer-executable instructions for performing ephemeral garbage collection, the computer-readable medium being accessible by a computing device, the instructions comprising:

requesting a list from a tracking mechanism, the list identifying memory locations that **have been accessed** since the last ephemeral garbage collection, each memory location corresponding to one of a plurality of cards associated with a card table, **wherein the card table identifies one or more cards that have been accessed**, each card being associated with one or more objects allocated from within a memory heap;

identifying at least one marked bundle based on the list, wherein the marked bundle corresponds to marked cards that represents a subset of the plurality of **cards having associated objects that have been accessed since a last garbage collection process**;

for each marked bundle, determining at least one marked cards within the marked bundle;

for each marked card, determining at least one accessed object within the marked card; and

performing garbage collection upon the at least one accessed object.

As shown above, amended independent Claim 1 recites “**wherein the card table identifies one or more cards that have been accessed**”, and “**plurality of cards having associated objects that have been accessed since a last garbage collection process**”. As described in the specification of the present application, the present technique tracks memory access to cards, the indications of which are reflected in a card table. Then, when garbage collection is requested, this indication of access to cards is used to correlate the memory accesses to one of a plurality of

bundles. Thus, as further described in the specification, by tracking the memory access to the card table, the present technique does not have the performance overhead of locating and setting a card bundle each time a store operation is performed in the code.

The Grarup reference discloses access to objects that are reflected in cards, including an array of cards (many cards), but does not disclose a table that reflects access to the cards themselves. Applicant uses the card table itself. The garbage collection process uses information obtained from the tracking mechanism to identify the bundles, and the card table is used to identify the cards. This card table that identifies cards that have been accessed, as recited in amended claim 1 is not present in the Grarup reference. For at least the reasons discussed above, amended Claim 1 is allowable in view of the Grarup reference.

**Claims 2-11** depend from Claim 1 and are allowable as depending from an allowable base claim. These claims are also allowable for their own recited features which, in combination with those recited in Claim 1, are neither shown nor suggested by the Grarup reference. For at least the reasons, Claims 2-11 are allowable. Therefore, the Applicant respectfully submits that the §102 rejection of Claim 2-11 is improper, and respectfully requests reconsideration and withdrawal of this rejection.

**Claim 12** has been amended to clarify the elements that are not taught or suggested by the Grarup. For convenience, amended Claim 12 is reproduced below with portions in bold to better emphasize some of the elements that are not taught or suggested in the prior art of record.

12. A method for executing statements within a program to support ephemeral garbage collection, the method comprising:

specifying a range of card table memory to watch during program execution, the card table memory identifying **prior access** to a plurality of cards, each card being associated with **and updated upon access to** one or more objects allocated within a memory heap, the memory heap being divided into the plurality of cards with each card being grouped into one of a plurality of bundles; and

for each store statement within the program, storing a value at a memory location within the heap memory based on the store statement, marking one of the plurality of cards within the card table memory based on the memory location, and tracking access to the card table memory.

The Examiner contends that the Grarup reference anticipates Claim 12. As shown above, amended independent Claim 12 recites “the card table memory identifying **prior access to** a plurality of cards, each card being associated with **and updated upon access to** one or more objects allocated within a memory heap”. As described above, a store process is performed whenever a store operation is encountered during a program’s execution. At some point, a garbage collection process is requested to free up some memory. Amended Claim 12 is directed at the store process. Thus, as further described in the specification, by tracking the memory access to the card table that identifies access to cards, and not just access to objects that the cards represent, the present technique does not have the performance overhead of locating and setting a card bundle each time a store operation is encountered in the code. Grarup does not does not teach updating a table on access to cards and thus does not teach or suggest amended Claim 12. Therefore, the Applicant respectfully submits that the §102 rejection of amended Claim 12 is improper, and respectfully requests reconsideration and withdrawal of this rejection.

**Claims 13-18** depends from independent Claim 12 and are allowable as depending from an allowable base claim as discussed above. These claims are also allowable for their own recited features which, in combination with those recited in Claim 12, are neither shown nor suggested by the Grarup reference. Therefore, the Applicant respectfully submits that the §102 rejections of Claim 13-18 is improper, and respectfully requests reconsideration and withdrawal of this rejection.

**Claim 19** has been amended to clarify the elements that are not disclosed by the Grarup reference. For convenience, Claim 19 is reproduced below with portions in bold to better emphasize some of the elements that are not disclosed in the Grarup reference.

19. A system for performing ephemeral garbage collection, the system comprising:

a processor; and

a memory into which a plurality of instructions are loaded and into which a plurality of objects are dynamically allocated, the memory having a heap into which the objects are allocated, the heap being divided into a plurality of cards which are grouped into a plurality of bundles, each card being associated with one or more of the plurality of objects; wherein upon execution of the plurality of instructions by the processor, the system being configured to:

request a list from a tracking mechanism, the list identifying memory locations that have been written into since a last garbage collection cycle, each memory location corresponding to one of a the plurality of cards associated with a card table, **wherein the card table identifies one or more cards that have been accessed;**

identify at least one marked bundle based on the list, wherein the marked bundle **corresponds to marked cards that** represents a subset of the plurality of **cards having associated objects that have been accessed since a last garbage collection process;**

determine, for each marked bundle, at least one marked card within the marked bundle, the at least one marked card indicating that one or more objects associated with the marked card has been accessed;

determine, for each marked card, the one or more objects that has been accessed; and  
perform garbage collection upon the one or more accessed objects.

The Examiner contends that the Garup reference anticipates Claim 19. Claim 19 has been amended in a similar manner as Claim 1. Accordingly, for all of the reasons discussed above with regards to Claim 1, this claim is allowable.

**Claims 20, 22 and 23** depend from Claim 19 and are allowable as depending from an allowable base claim. These claims are also allowable for their own recited features, which, in combination with those recited in Claim 19, are neither shown nor suggested by the Garup reference.

**Claims 21-24** depend from independent Claim 19, and are allowable as depending from an allowable base claim as discussed above. These claims are also allowable for their own recited features which, in combination with those recited in their respective independent claims, are neither shown nor suggested by the Garup reference alone or with any permissible combination of the prior art of record. Further amended claim 21 recites “wherein the write-watch mechanism resides within a memory manager **and sets bits in the card table upon access to at least one of the plurality of cards.**” Also amended claim 24 recites “**further comprising setting a bit in the card table to identify one or more cards that have been accessed.**” Setting a bit in the card table to identify cards that have been access is not disclosed in the Garup reference. Therefore, the Applicant respectfully submits that the §102 rejections of amended Claims 21-24 is improper, and respectfully requests reconsideration and withdrawal of this rejection.

### Conclusion

Applicant has considered the other references cited by the Examiner in the Office Action. None of these references appear to affect the patentability of Applicant's claims. By the foregoing remarks, Applicant believes that all pending Claims 1-24 are allowable and the application is in condition for allowance. Therefore, a Notice of Allowance is respectfully requested. Should the Examiner have any further issues regarding this application, the Examiner is requested to contact the undersigned attorney for the Applicant at the telephone number provided below.

Respectfully Submitted,

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